

Fig. 2

Calculation

Since $\lambda \gg R_0 \sqrt{\varepsilon}$

The field distribution is approximately quasi-static and can be calculated by the method of images.

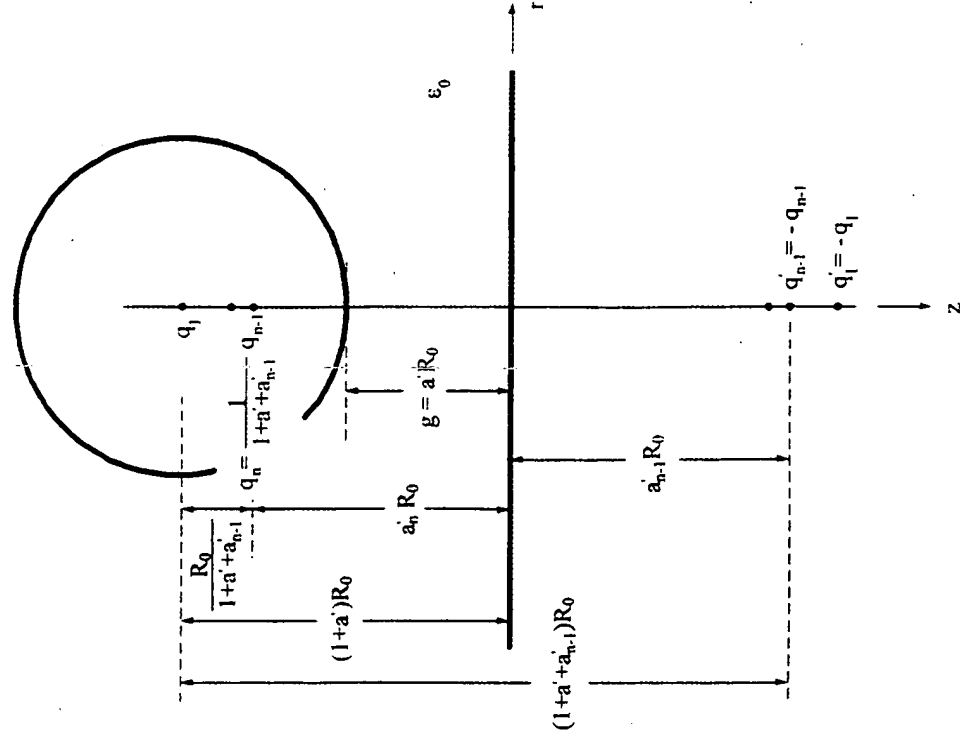


Fig. 3

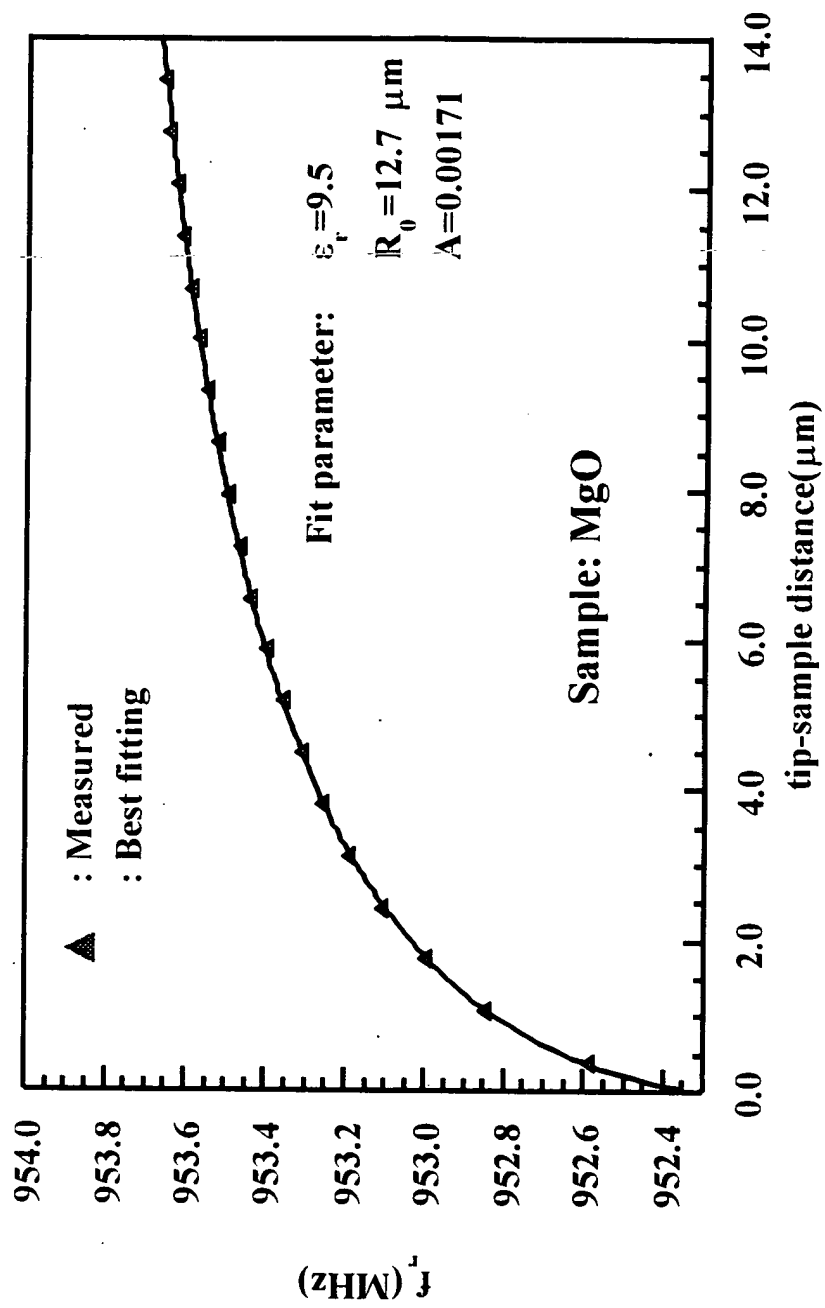


Fig. 4

$$(\frac{\delta f}{f_0})\omega = A \epsilon_{333} E_1$$

$$\bar{E}_l = \frac{1}{32} \frac{V}{R_0} \frac{\epsilon_{33} + \epsilon_0}{2\epsilon_0}$$

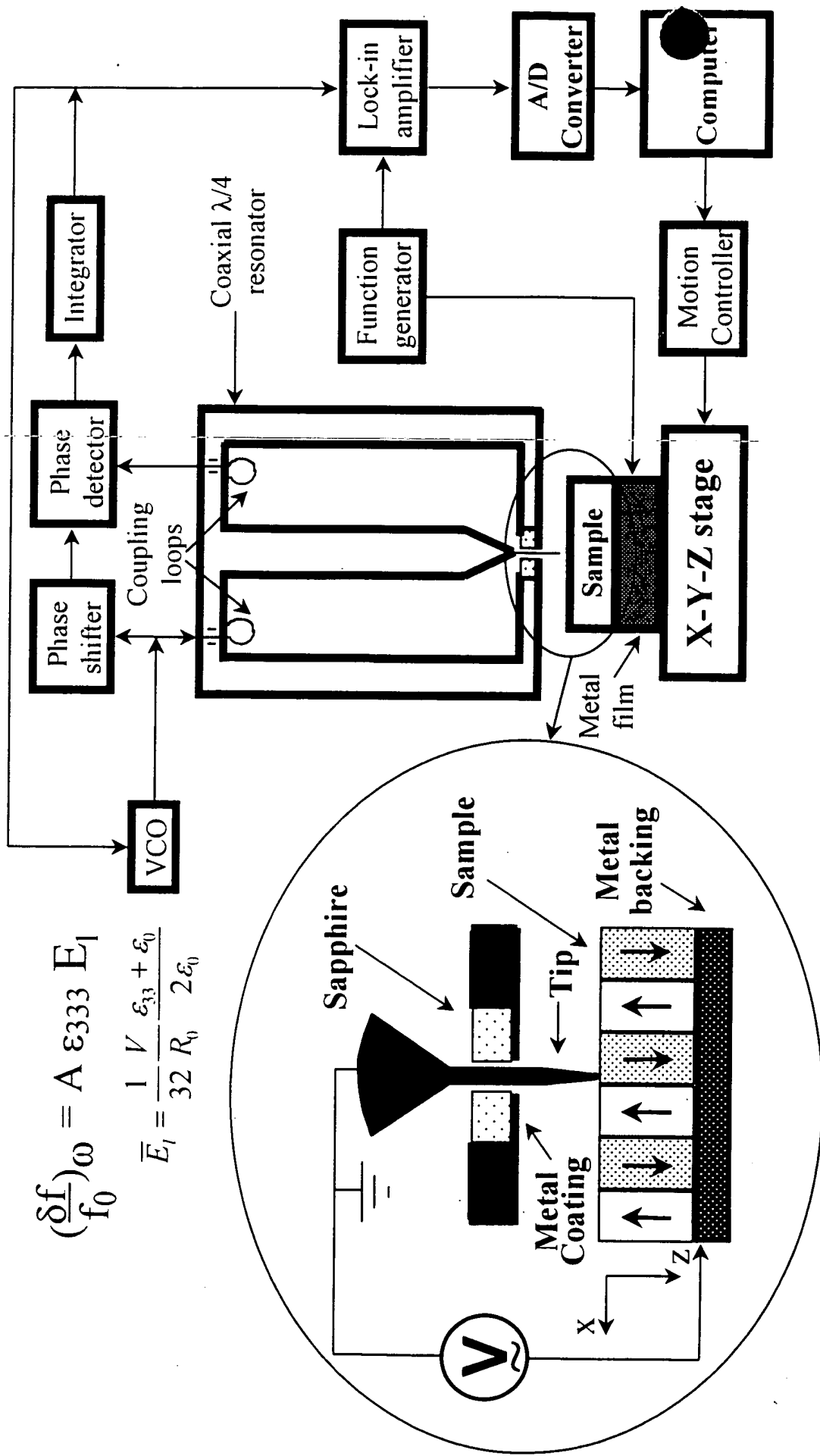
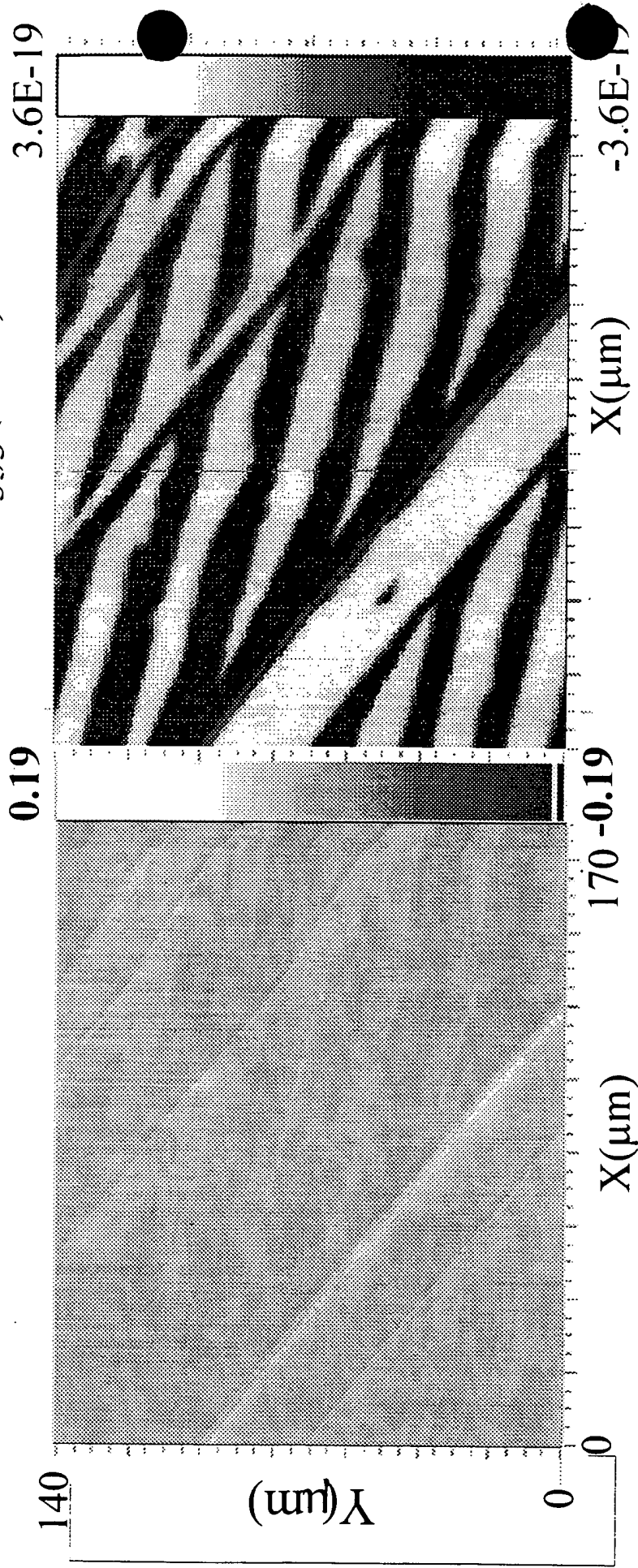


Fig. 6

$$\Delta \varepsilon_{33}(E_l) = \frac{\partial D_3}{\partial E_m} = \varepsilon_{33} + \varepsilon_{333}(E_l + E_m) + \frac{1}{2} \varepsilon_{3333}(E_l + E_m)^2 + \dots$$

$$\varepsilon_{333}(F/V)$$



Sensitivity $\Delta\varepsilon/\varepsilon \sim 10^{-3}$

Fig. 7

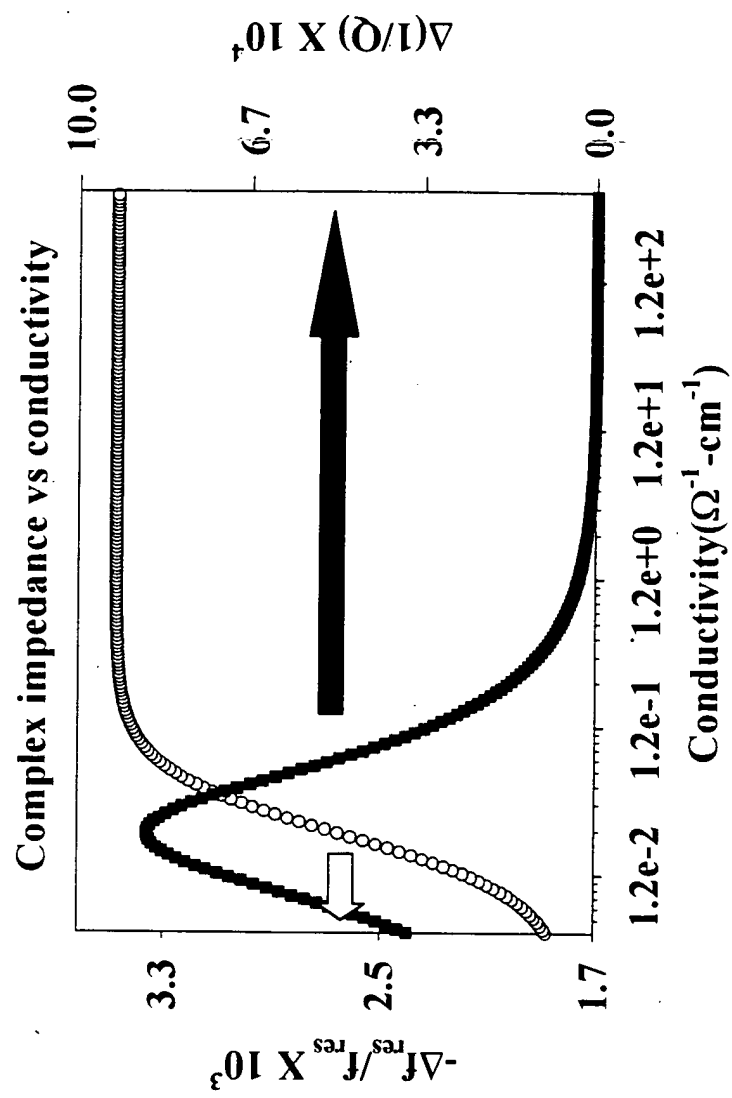


Fig. 8

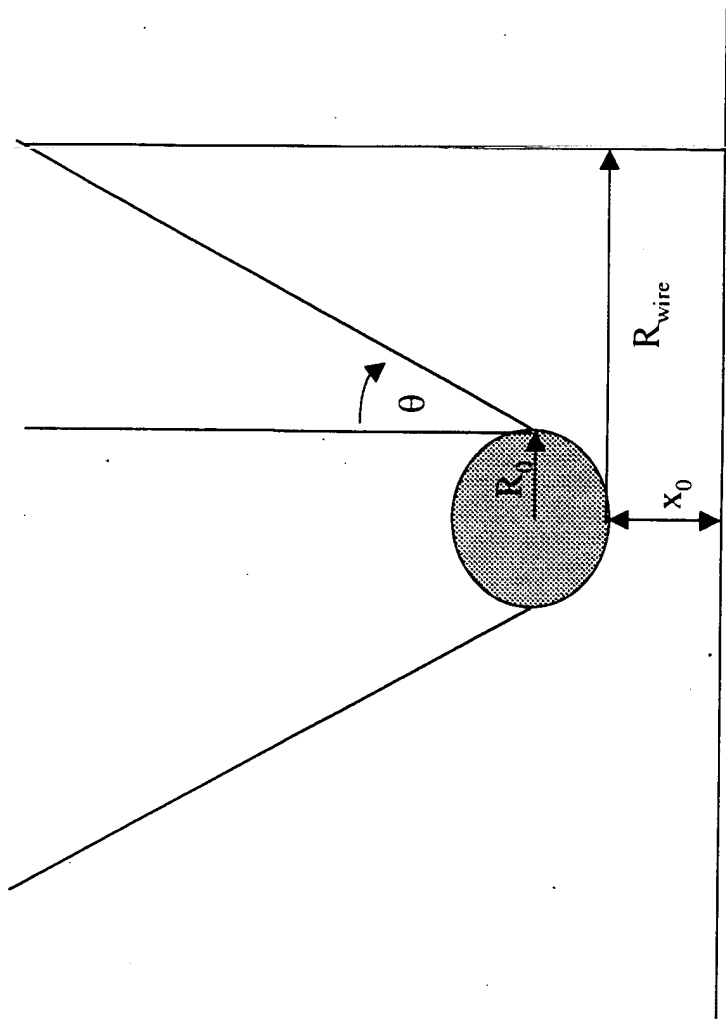


Fig. 9

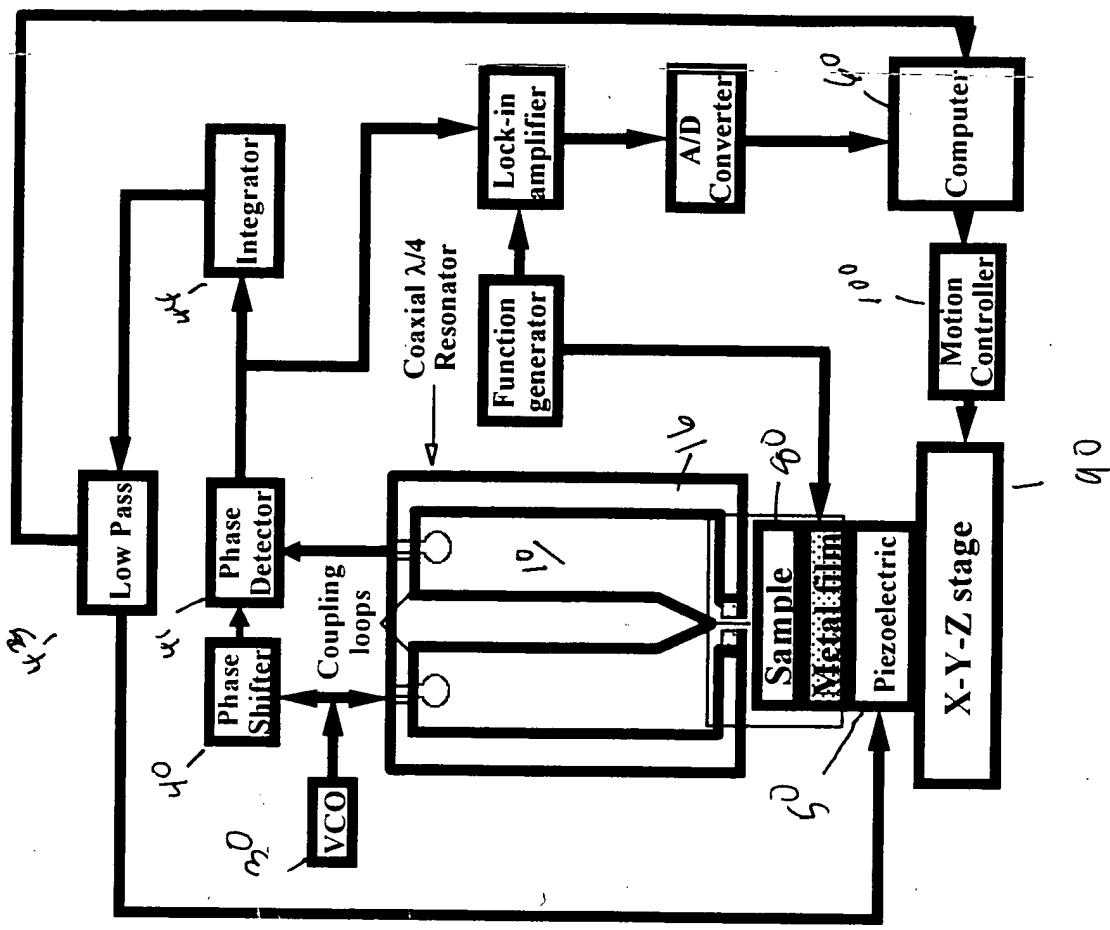


Figure 11

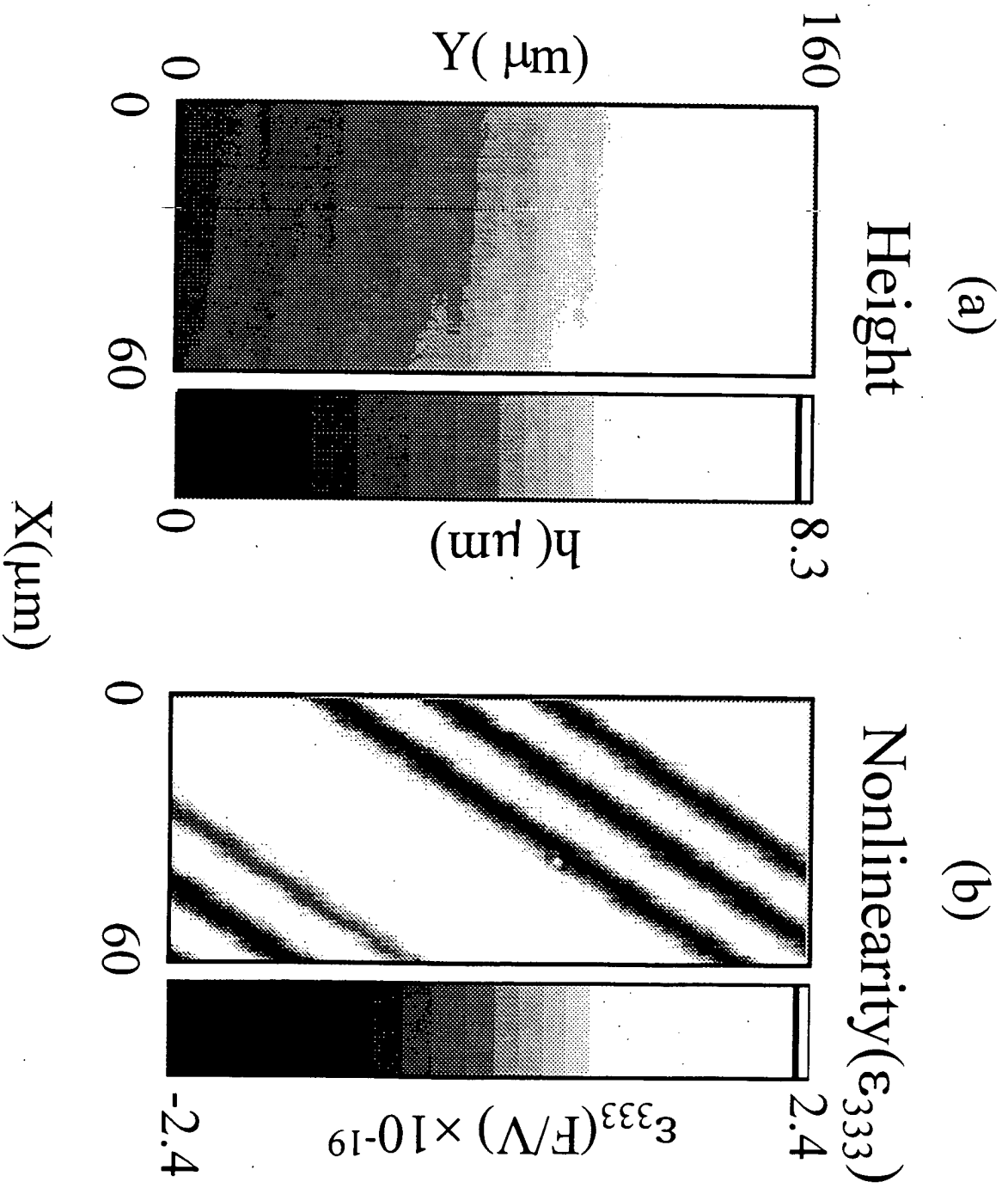


Figure 12

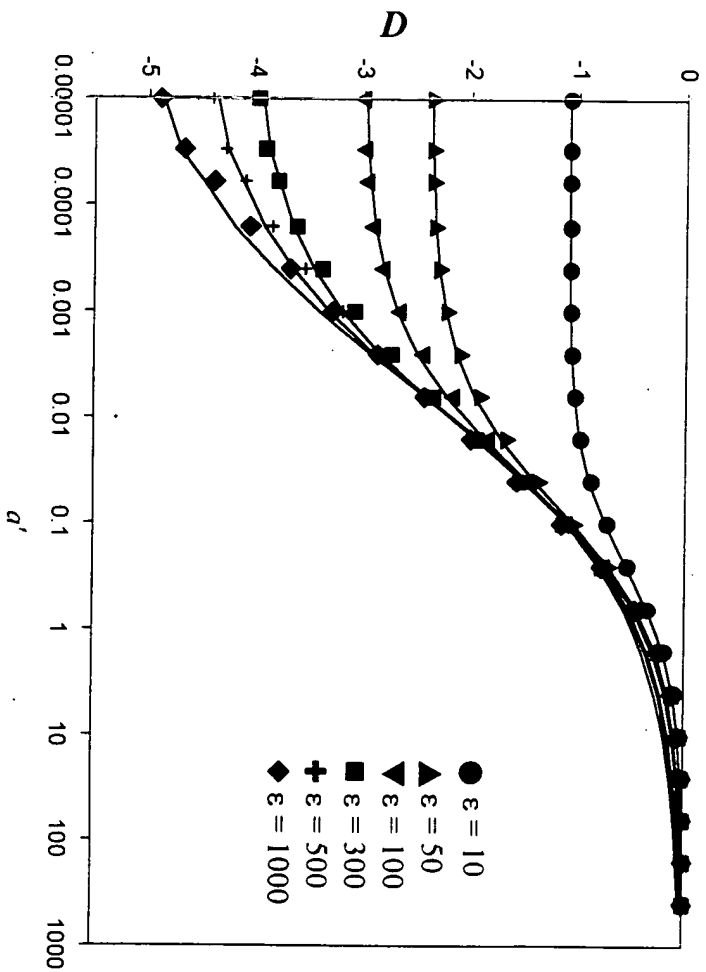
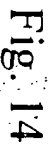
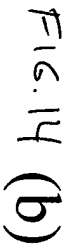


Fig. 13

1000 100 10 1 0.1 0.01 0.001 0.0001 0.00001

FIG. 14 (a)



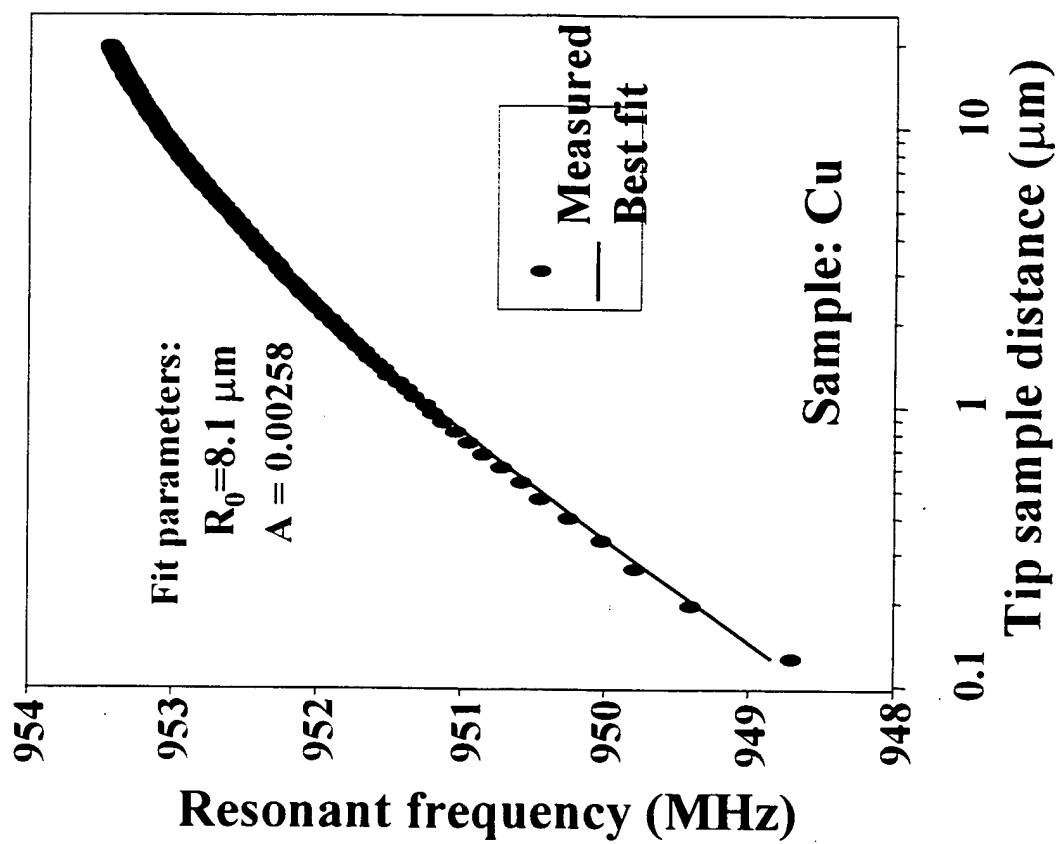
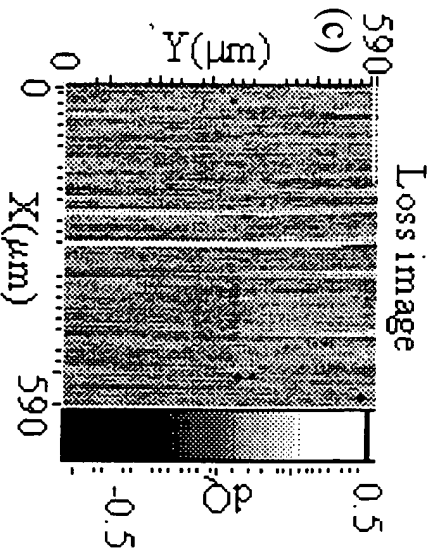
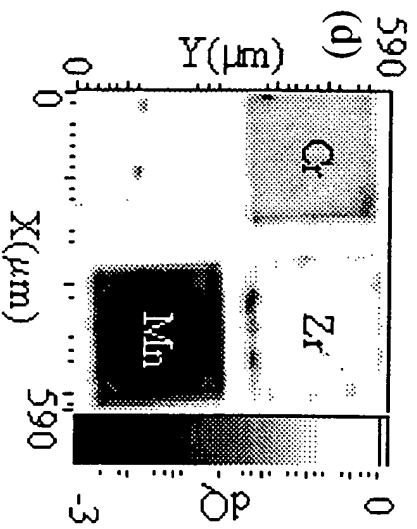


Fig. 15

Topographic image



Topographic image



Loss image

[illegible]

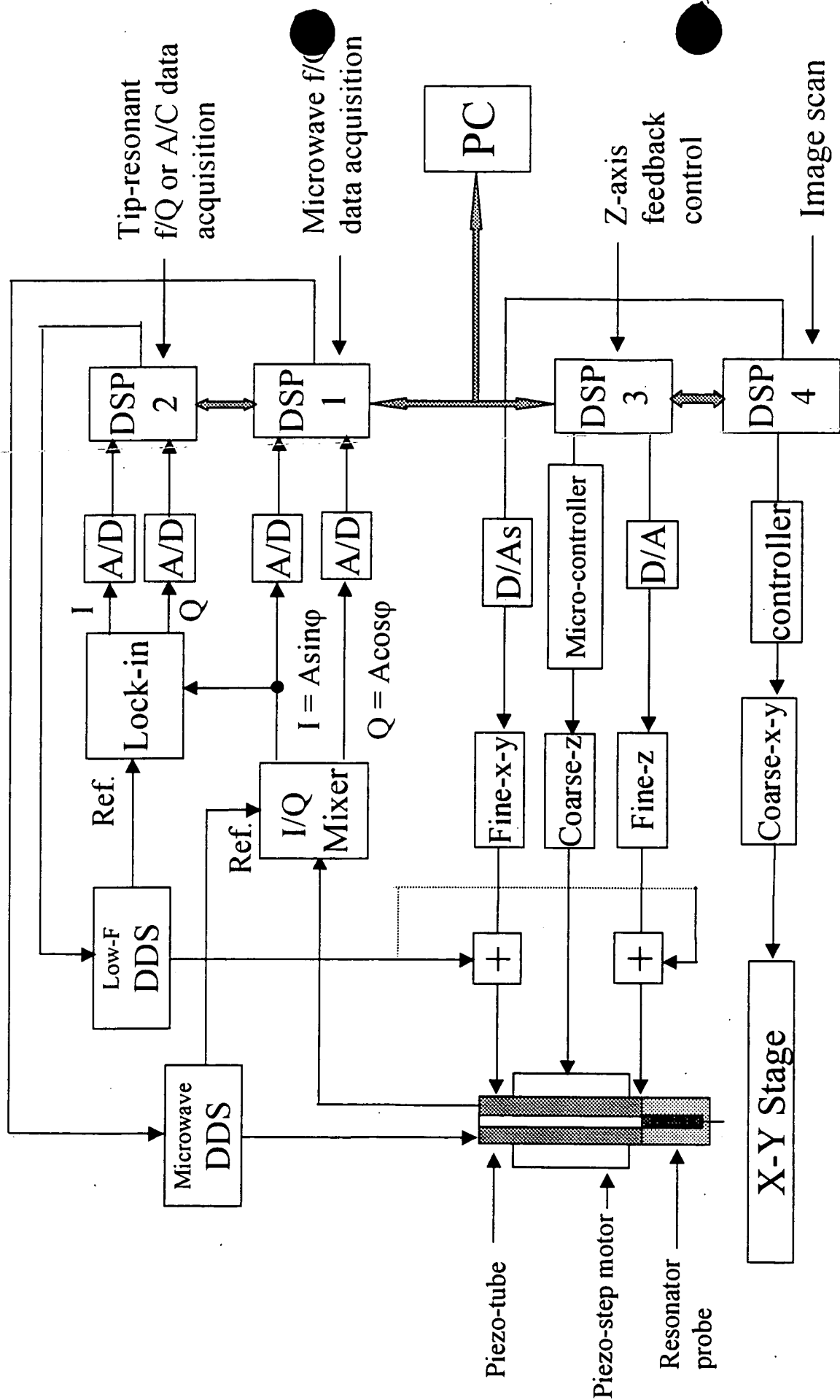


Fig. 17

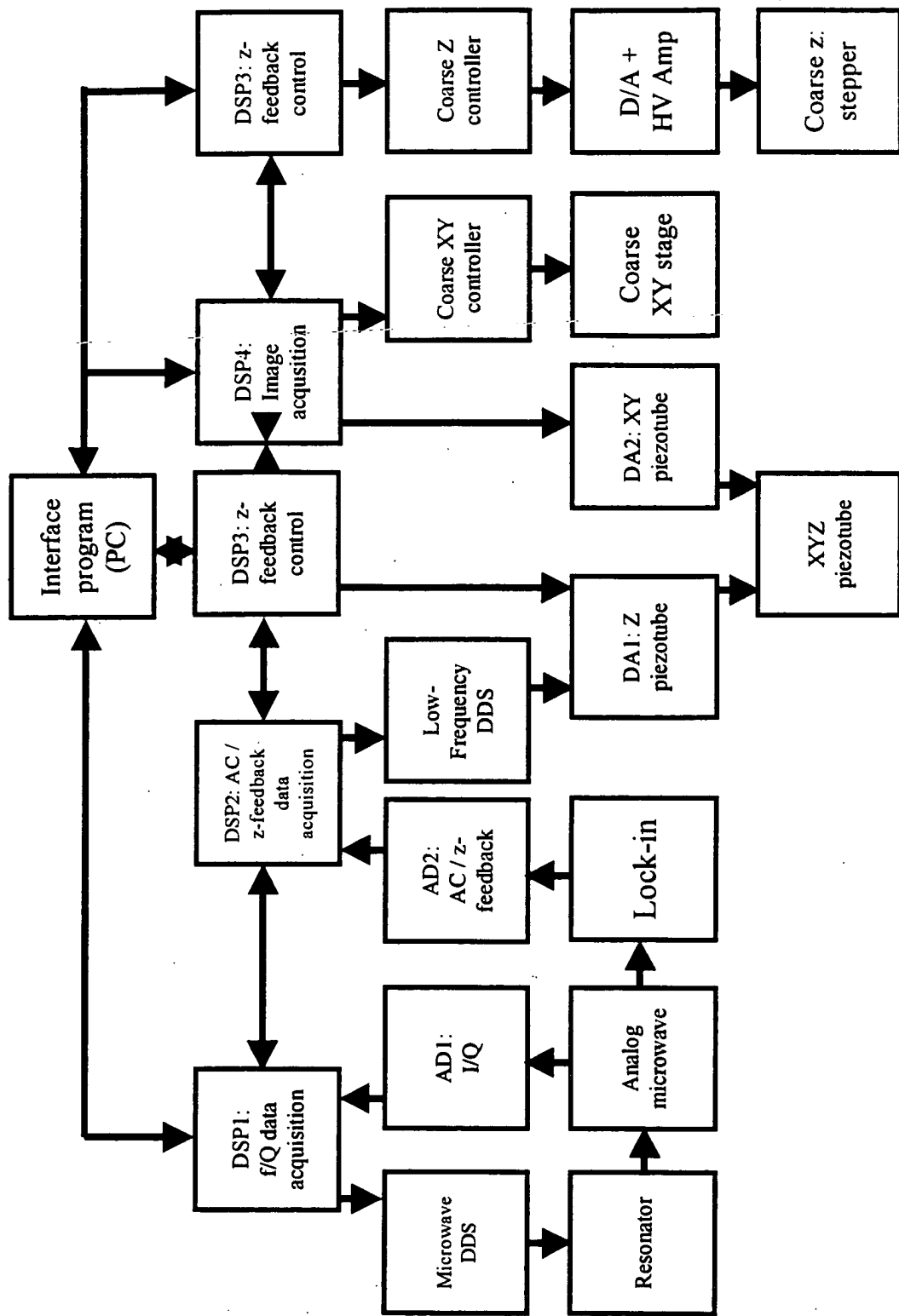


Fig. 18

Figure 19. Forward and backward stepping of a piezoelectric actuator.

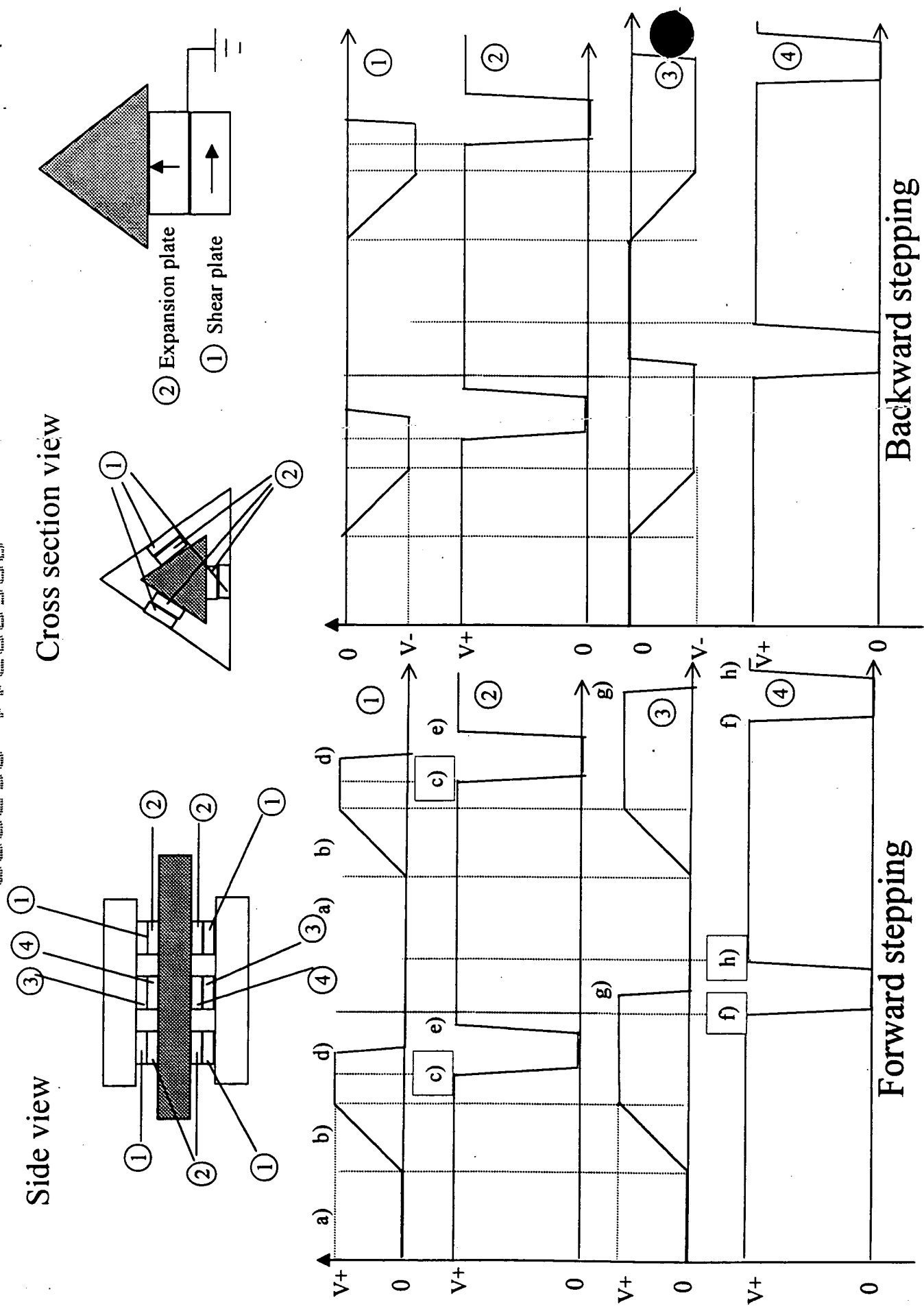


Figure 19.

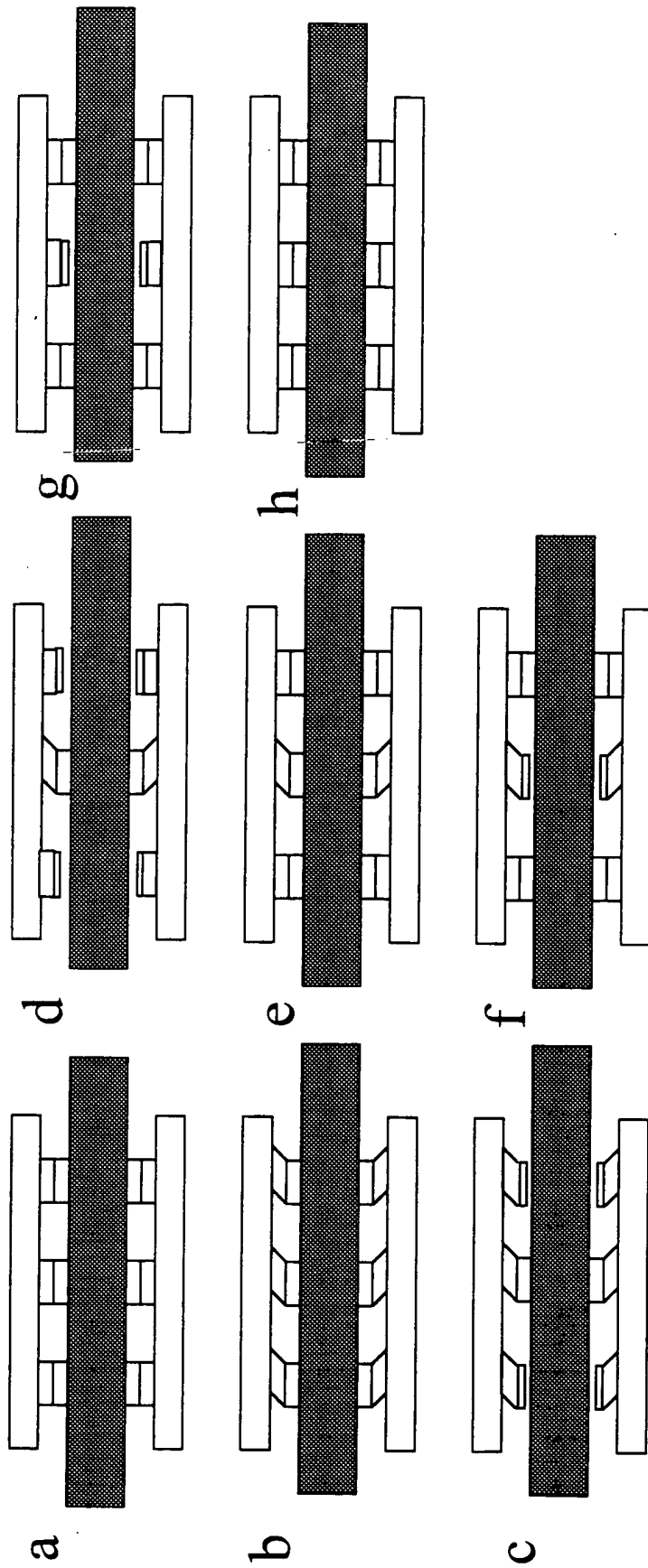


Figure 20.

Integration of AFM

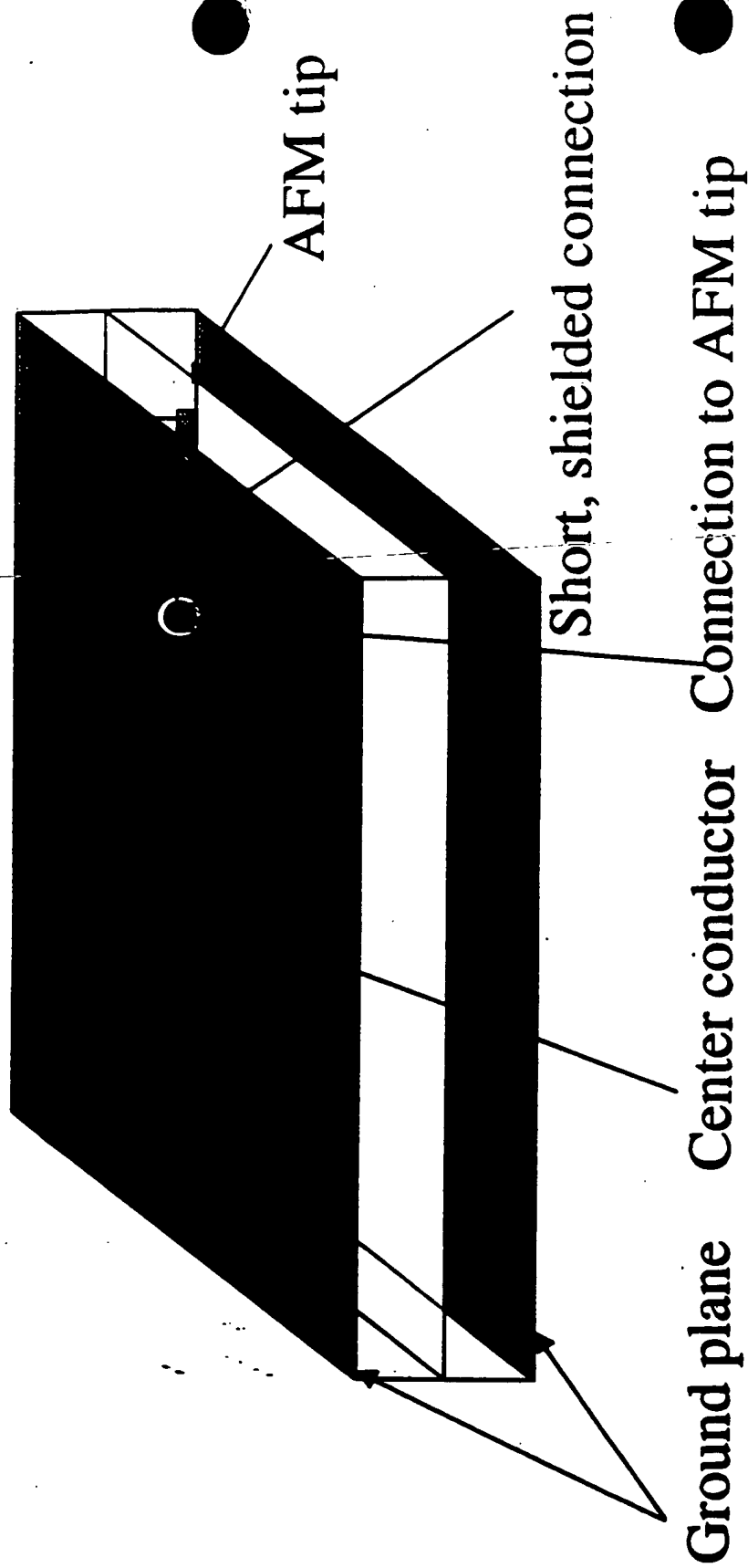


Figure 2/.

Single Crystal Measurement

Material	Measured ϵ_r	Reported ϵ_r	Measured $\tan\delta$	Reported $\tan\delta$
YSZ	30.0	29	1.7×10^{-3}	1.75×10^{-3}
LaGaO ₃	23.2	25	1.5×10^{-3}	1.80×10^{-3}
CaNdAlO ₄	18.2	~19.5	1.5×10^{-3}	$0.4 - 2.5 \times 10^{-3}$
TiO ₂	86.8	85	3.9×10^{-3}	4×10^{-3}
BaTiO ₃	295	300	0.47	0.47
YAlO ₃	16.8	16	-	8.2×10^{-5}
SrLaAlO ₄	18.9	20	-	-
LaAlO ₃	25.7	24	-	2.1×10^{-5}
MgO	9.5	9.8	-	1.6×10^{-5}
LiNbO ₃ (X-cut)	32.0	30	-	-

Table 1

Films	SEMM (1 GHz)		Interdigital Electrodes (1 GHz)	
	ϵ_r	$\tan \delta$	ϵ_r	$\tan \delta$
$\text{Ba}_{0.7}\text{Sr}_{0.3}\text{TiO}_3$	707	0.14	750	0.07
$\text{Ba}_{0.5}\text{Sr}_{0.5}\text{TiO}_3$	888	0.19	868	0.10
SrTiO_3	292	0.02	297	0.015
$\text{Ba}_{0.24}\text{Sr}_{0.35}\text{Ca}_{0.41}\text{TiO}_3$	150	0.05		
$\text{Ba}_{0.25}\text{Sr}_{0.35}\text{Ca}_{0.4}\text{TiO}_3$	240	0.05		

Table 2